(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 767 445 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.04.1997 Bulletin 1997/15

(51) Int Cl.[6]: **G06T 11/00**, G06T 7/40

(21) Application number: **96307166.7**

(22) Date of filing: **30.09.1996**

(84) Designated Contracting States:
DE ES FR GB IT NL

(30) Priority: **02.10.1995 JP 255140/95**
28.12.1995 JP 343849/95

(71) Applicant: **CANON KABUSHIKI KAISHA**
Tokyo (JP)

(72) Inventors:
- **Hidaka, Yumiko**
  Tokyo (JP)
- **Mizuno, Toshiyuki**
  Tokyo (JP)
- **Shiraiwa, Yoshinobu**
  Tokyo (JP)

(74) Representative:
Beresford, Keith Denis Lewis et al
BERESFORD & Co.
2-5 Warwick Court
High Holborn
London WC1R 5DJ (GB)

(54) Image processing apparatus and method

(57) An image processing apparatus is constructed by a setting circuit for manually setting a first color processing parameter, a first color processing circuit for performing a first color process by using the first color processing parameter, a storing circuit for storing a second color processing parameter set in correspondence to the first color processing parameter as a reference value, and a second color processing circuit for performing a second color process different from the first color process by using the second color processing parameter, wherein in case of making the second color processing circuit function, the first color processing parameter is set to the reference value.

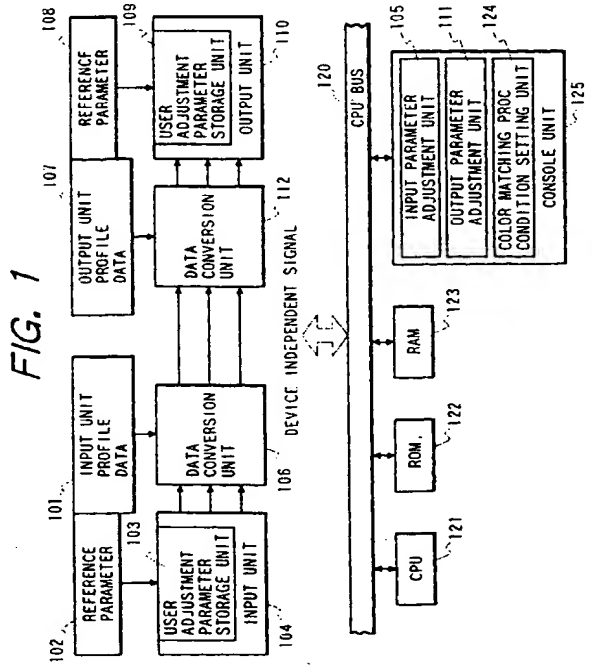


FIG. 1

BEST AVAILABLE COPY

EP 0 767 445 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to image processing apparatus and method for performing a color process.

Related Background Art

In recent years, problems such that various color reconstructions are performed due to a difference of a coloring mechanism of every input/output device or a difference of a coloring material to be used because of a spread of networks and an enlargement of a demand for a color product and that a color matching function differs every kind of apparatus have been pointed out. There is a color management system (CMS) as a technique which is highlighted to solve those problems. At present, to solve the problems, a process for matching the colors of input and output images by connecting the system to a computer and performing a data conversion using profile data formed every input/output equipment by using a software (CMS software) is executed.

Even if the same signal is inputted, the same color is not always outputted due to a difference of the device. Therefore, information regarding characteristics of input/output signals in input/output equipment which was set in a reference state in order to suppress the characteristics of each device has been stored in the profile data. Input/output characteristics of the signal of the device are distinct by the profile data of each device and by correcting by using the profile data, the colors can be matched irrespective of the device.

The data conversion will now be described with reference to Fig. 7. In the diagram, device characteristics data regarding input equipment has been stored in input equipment profile data 101. Device characteristics data regarding output equipment has been stored in output equipment profile data 107.

A color signal obtained from the input equipment is converted by a data conversion unit 106 by using the input equipment profile data 101. The converted data is a color signal which doesn't depend in each device. In further another data conversion unit 112, the data is converted into a color signal suitable for each output equipment by using the output equipment profile data 107 and is outputted by using such a color signal.

At present, input/output equipment such as monitor, printer, scanner, or the like which is most frequently used has a function for changing the color or brightness in accordance with a taste of the user. The monitor generally has a knob to adjust the brightness and contrast. To obtain a preferable image in consideration of a fatigue of the eyes, the user can adjust the brightness of the monitor by freely moving the knob. In a monitor which can perform a further advanced correction, a formation of a gamma table, a change in color temperature of the monitor, and the like can be performed.

In a manner similar to the above, there is also a printer having the correcting function to obtain a desired color of the user by a method such that an output balance of colors is adjusted, an LUT is formed, or the like.

As mentioned above, when input/output equipment which can be adjusted by the user is used, there occurs a problem such that by the execution of the adjustment by the user, a state of the input/output equipment when the profile data is formed and a state of the equipment when data is actually inputted or outputted are different, so that an accurate color matching cannot be performed.

Such a problem also occurs in the color management system for performing a color matching process according to an illumination light, namely, a color managing technique which has been proposed in recent years.

A construction in the case where an image of an original is read by an image scanner and the read image is displayed on a monitor screen and an ambient light is considered will now be described. Fig. 7 shows a schematic constructional block diagram. An image scanner 10 reads out the image of the original and outputs the read image data in an (R, G, B) form. A scanner color conversion device 12 converts an output signal of an RGB colorimetric system of the scanner 10 into a standard colorimetric system (XYZ colorimetric system) with reference to a scanner profile 14 which has previously been formed from image reading characteristics of the image scanner 10.

A signal conversion device 16 corrects an output of the conversion device 12 in consideration of an ambient light in accordance with ambient color information which is supplied from the ambient light sensor 18 to detect color components or a color distribution of the ambient light.

In accordance with a monitor profile 22 which reflects coloring characteristics of a monitor display (hereinafter, abbreviated to a monitor) 24 to be used, a monitor color conversion device 20 converts the output signal of the XYZ colorimetric system of the signal conversion device 16 into values of an RGB space in consideration of the coloring characteristics of the monitor 24 and supplies to the monitor 24.

An environment where the image is observed will now be simply explained with reference to Fig. 8. A printed matter is read by the image scanner 10 and the read image is displayed as an image (original image) on the screen of the monitor 24. The illumination light from a fluorescent light or the like illuminates an ambient portion as an ambient light.

The ambient light sensor 18 is put onto the monitor 24, a printer 30, or a computer main body and detects a color distribution or color components of the ambient light. The original image is generally displayed on the screen of the monitor 24 so as to be overlaid to a background color (color of the screen). Therefore, the user simultaneously looks at both of the background color and the original image and recognizes the color of the original image.

The ambient light changes depending on a situation. According to the existing color managing technique, the ambient light is detected by the ambient light sensor 18 and, in accordance with the detection information, the signal conversion device 16 corrects an output of the scanner color conversion device 12, namely, the color signal of the standard colorimetric system. Thus, the coloring of the original image which is displayed on the screen of the monitor 24 is adjusted in accordance with the ambient light. Namely, a colorimetrological coincidence is realized.

Although the colors of the same value on the standard color space inherently ought to be seen as a same color, in the case where both colors are a color of the monitor (light source color) and a color of the printed matter (object color) and even if they have the same value on the standard color space, they cannot be seen as a same color for the human eyes due to a difference of the visual environment, mode, or the like. As for such a problem, the following correcting techniques have also been proposed in order to enable the human being to perceive them as a same color by observing with the eyes.

It is considered that when observing colors, the human being uses white as a reference and recognizes all of the colors by comparing with white. It is now considered a case, as an example, of observing a monitor display image put under a certain ambient light and a printed matter put under the same or a different ambient light. There are a number of white colors which should be reference colors such as white of the monitor screen, white of the environmental light, white of a paper illuminated by the environmental light, and the like. It is possible to regard such that the colors are observed by using a white color adapted to such a number of white colors at a certain ratio as a reference. A method whereby by calculating reference white and converting the colors of all of the image by setting such white as a reference, observation colors are mutually matched is considered. Actually, when reference white is calculated, one adaptation ratio of white of the monitor screen under the fluorescent light to the ambient light is determined and reference white is calculated by using such an adaptation ratio.

As shown in Fig. 8, when observing the original image which is displayed on the screen of the monitor 24, both of the original image and the ambient color (background color) simultaneously enter the eyes. Since the human being recognizes the color by a comparison with the circumstances, it has been known that if the colors displayed in the center portion are the same and the background colors are different, the colors of different impressions are perceived. Therefore, even in case of displaying the same image, if the background color differs, the color of the display image is recognized as a different color.

SUMMARY OF THE INVENTION

The invention is made in consideration of the above points and it is a concern of the invention to realize a highly-accurate color matching.

Particularly, a concern of the invention is to enable an effect of a preset color process to be most efficiently derived.

According to the invention, there is provided an image processing apparatus comprising: setting means for manually setting a first color processing parameter: first color processing means for performing a first color process by using the first color processing parameter: storing means for storing a second color processing parameter which has been set in correspondence to the first color processing parameter as a reference value; and second color processing means for performing a second color process different from the first color process by using the second color processing parameter, wherein when the second color processing means is made function, the first color processing parameter is set to the reference value.

Another concern of the invention is to provide a highly-accurate color matching on the basis of an application of the user.

According to another aspect of the invention, there is provided an image processing apparatus having first and second color matching modes for performing different color matching processes, comprising: selecting means for selecting the color matching mode on the basis of an instruction of the user: and setting means for setting a background color on a display screen to a predetermined color when the second color matching mode is selected by the selecting means.

The above and other features of the present invention will become apparent from the following detailed description and the appended claims with reference to the accompanying drawings

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram regarding an image processing apparatus according to the embodiment 1;

Fig. 2 is a flowchart for image processes according to the embodiment 1:

Fig. 3 is a constructional diagram of an image processing system according to the embodiment 2;
Fig. 4 is a block diagram showing an example of an image processing system according to a modification of the embodiment 1;
Fig. 5 is a block diagram showing an example of an image processing system according to a modification of the embodiment 1;
Fig. 6 is a flowchart for image processes according to the embodiment 2;
Fig. 7 is a schematic constructional block diagram of an image processing apparatus according to the embodiment 3;
Fig. 8 is a schematic diagram showing an arrangement of blocks in the embodiment shown in Fig. 7;
Fig. 9 is a schematic constructional block diagram in a signal conversion device 16;
Fig. 10 is a schematic diagram showing the relations among an ambient light, white and a background color of a monitor, and reference white;
Fig. 11 is a schematic constructional block diagram of a modification;
Fig. 12 is an operating flowchart for the modification shown in Fig. 11;
Fig. 13 is a block diagram of an image processing apparatus according to a prior art;
Fig. 14 is a schematic constructional block diagram of the prior art: and
Fig. 15 is a diagram for explaining a general use environment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments according to the invention will now be described hereinbelow with reference to the drawings.

[Embodiment 1]

The embodiment 1 relates to an example when the invention is applied to an image processing apparatus having an input unit, an output unit, and a color matching processing function.

According to a color matching process, a data conversion is executed so as to equalize a color reconstruction irrespective of a device on the basis of input/output profiles showing input/output characteristics which are different every input/output device.

Fig. 1 shows a block diagram of the image processing apparatus according to the embodiment 1.

Information regarding characteristics of input/output signals in each input/output device which was set into a reference state has been stored in profile data of the input unit and output unit.

Further, a parameter regarding the reference state of an input unit 104 at the time of formation of the input unit profile is added as a reference parameter 102 to the input equipment profile data. Similarly, a reference parameter 108 at the time of the formation of an output equipment profile is added to the output equipment profile data. For example, in case of a monitor which is used as input/output equipment, parameters regarding the image adjustment such as gamma characteristics, contrast, brightness, color temperature of white, and the like have been stored in the reference parameter.

As an example of a method of forming the profile data, in case of a printer, first, the apparatus is set into a reference state and a reference sample in which a certain input signal has already been known is outputted and color characteristics of the outputted sample are measured. The relation of the input/output signals is stored as profile data.

Device characteristics data regarding the input unit 104 has been stored in the input equipment profile data 101. Device characteristics data regarding an output unit 110 has been stored in the output equipment profile data 107.

User adjustment parameter storage units 103 and 109 exist in the input/output units and parameters regarding the image adjustment including values which were freely set by the user by using knobs, menu bars, and the like provided for a user adjustment unit 105 and output parameter adjustment unit 111 have been stored in the storage units 103 and 109.

When the input unit or output unit is solely used without using a CMS software, ordinarily, an image is inputted or outputted by using the parameters stored in the user adjustment parameter storage units.

However, when the color matching process is executed, in order to realize a color reconstruction of a high quality, it is necessary to set into a reference state when each profile data is formed.

Namely, it is necessary to set the parameters of the input/output units in correspondence to the input/output profile data.

For this purpose, which one of the user adjustment parameter 103 and the reference parameter 102 at the time of the formation of the input equipment profile should be used needs to be decided by a color matching processing condition setting unit 124 in accordance with the input/output environment of the image.

A flow of processes according to the embodiment 1 will now be described hereinbelow with reference to Fig. 2.

First, whether the color matching process is executed or not is set by the color matching processing condition

setting unit 124 in a console unit 125 (S10).

When the color matching process is executed, the processing parameters in the input unit 104 and output unit 110 are set to the reference values when the profiles are formed (S20).

An inputting process is executed on the basis of the reference values set in the input unit 104, thereby obtaining input image data (S30).

As mentioned above even if the user adjustment parameters are used, in case of matching the colors of input and output images by using the color matching process, the reference parameter 102 which has previously been added to the input equipment profile data is used in place of the user adjustment parameter 103. At this time, the user adjustment parameters are rewritten and the control of the input unit can be performed or the control of the input unit can be also directly performed by using the reference parameter irrespective of the user adjustment parameters. As mentioned above, the input image data is obtained by the input equipment set in the reference state.

In the data conversion unit 106, the input image data is subjected to a data conversion process 1 for converting into data (device independent signal) which doesn't depend on the device on the basis of the input equipment profile data 101 (S40).

In the data conversion unit 112, a data conversion process 2 for converting into output image data suitable for an output device is executed on the basis of the output equipment profile data 107 (S50).

Namely, in the data conversion process 1, the input image data depending on the input unit is converted into the device independent data by using the input equipment profile data. In the data conversion process 2, the device independent data is converted into output image data which depends on the output unit by using the output equipment profile data.

In a manner similar to the input unit, even if the user adjustment parameters have been set, in case of matching the colors of the input and output images by using the color matching process, the reference parameter 108 which has previously been added to the output equipment profile data and has been set in step S20 is used in place of the user adjustment parameters 109, thereby obtaining output image data from the output unit 110 set in the reference state.

On the other hand, when a mode such that the color matching process is not executed is set in step S10. the parameters of the input unit and output unit are arbitrarily manually set in accordance with an application of the user by using the user adjustment unit 105 and output parameter adjustment unit 111 of a console unit 25 (S70).

When the parameters of the input unit and output unit have been preset in accordance with the application of the user, those parameters can be also used.

An input process is executed in the input unit and an output process is executed in the output unit in accordance with the set parameters (S80 and S90).

Each unit of the image processing apparatus is controlled by a CPU 121 connected through a CPU bus 120.

The CPU 121 controls each of the above units by using an RAM 123, as a work memory, on the basis of, for example, a program to execute processes shown in Fig. 2 stored in an ROM 122 in accordance with the setting of the console unit 125.

According to the embodiment 1, when the color matching process is executed, since the input and output processes are executed in the input/output units by the parameters suitable for the input/output equipment profiles which are used for the color matching processes which are executed by the data conversion units 106 and 112, an effect of the CMS process can be most efficiently derived.

That is, the colors can be matched irrespective of the input/output devices.

When the color matching process is not executed, an arbitrary process can be performed on the basis of a will of the user.

[Modification 1]

As a modification, an example in which the invention is applied to an image processing system as shown in Fig. 3 will now be described.

The image processing system is constructed by:
input equipment 204 and output equipment 205 corresponding to the input unit 104 and output unit 105 in the embodiment 1; and a computer 200 for performing the color matching process.

An example in the case where the user adjustment parameters exist in a memory of the computer for controlling instead of the input/output equipment will now be described hereinbelow with reference to Fig. 4.

Portions similar to those in the embodiment 1 are designated by the same reference numerals.

In a manner similar to the embodiment 1, when an image is inputted, whether the user adjustment parameters 103 are used or the parameters are set to the reference parameter 102 when each profile is formed is first determined in accordance with input/output environment of the image. Both of the user adjustment parameters and the reference parameter have been stored in the memory of the computer for controlling. When the colors of the input and output images are matched by a CMS (color management system) software, in a parameter selection unit 301, the reference

parameter 102 added to the input equipment profile data is selected. On the basis of the selected parameter, the input equipment is set into the reference state by an input equipment control unit 302. In the other case where the CMS software is not used, the user adjustment parameters 103 adjusted by the user are selected and the input equipment 204 is controlled by using the user adjustment parameters. Image data is obtained by such input equipment.

Even in the data conversion, a conversion similar to that in the embodiment 1 is executed. The control of the output equipment is also substantially the same as that for the input equipment. Either one of the user adjustment parameters 109 and reference parameter 108 is selected in accordance with the input/output environment of the image. An output image is derived from output equipment 210 controlled by using the selected parameter.

In the image processing system shown in Fig. 3, the reference parameter has been added to the input/output equipment profile data. However, as shown in Fig. 5, both of the user adjustment parameters 103 and 109 and the reference parameters 102 and 108 can be also stored into parameter storage units 401 and 402 of the input/output equipment by disconnecting from the input/output equipment profile data, respectively. It is also possible to arbitrarily select both of them in accordance with the input/output environment and to obtain an image by the input/output equipment controlled by the selected data.

Although the storing locations of the data have been limited in the above embodiment, the invention is not limited to the example as shown in the embodiment but the invention can be also sufficiently applied to a combination of them or a case where the storing positions of the user adjustment parameters and reference parameter are other than the locations mentioned in the embodiment.

That is, the user adjustment parameters can be also stored into input/output equipment main bodies.

[Embodiment 2]

In the foregoing embodiment 1, when the color matching processing mode is set, the user cannot set a user processing parameter.

Therefore, for example, when the user wants to finely adjust the image generated by the color matching process, the user has to set an ordinary mode in which the color matching process is not executed and to set parameters from the beginning.

In the embodiment 2, an example in which an image can be finely adjusted for a color matching processing result will now be described with reference to Fig. 6.

In Fig. 6, substantially the same processing steps as those in the embodiment 1 are designated by the same processing step numbers and their descriptions are omitted.

In Fig. 6, processes in steps S110 to S160 are added to the processes in the embodiment 1 in order to perform the fine adjustment mentioned above.

When the CMS processing mode is set in step S20, the color matching process (S10 to S50) is executed in a manner similar to the embodiment 1 and the image data which was color matching processed is stored into the RAM 123.

An image is outputted by using the reference parameter by the output unit 110.

Whether the output image is satisfactory or not is confirmed by the eyes (S120).

When the user satisfies the output image. the processing routine is finished.

On the other hand, when the user cannot satisfy the output image, in order to perform the fine adjustment, the parameters of the output unit are set by using the output parameter adjustment unit 111 (S130).

The image data which was CMS processed and stored in the RAM 123 is read out and an image is outputted by using the set parameters (S140).

The processes in steps S120 to S140 are repeated until a satisfactory output image can be obtained.

Each of the above embodiments has been shown and described on the assumption that, as for the selection between the user adjustment parameters and the reference parameter, when the color of the image is controlled by the CMS software, the reference parameter is selected and, in the other cases, the user adjustment parameters are used. However, it is also possible to automatically select the parameters or to arbitrarily select either one of those parameters in accordance with a desire of the user case by case.

Further, although the case where the number of reference parameters when the profile is formed is set to one parameter has been shown above, it is also possible to construct in a manner such that there are a plurality of reference parameters corresponding to the user adjustment values and a reference parameter at the time of control is newly formed as interpolation data of them.

Although the embodiments have been described above with respect to the input/output equipment, the invention can be also applied to any other various combinations such as (scanner and monitor), (monitor and printer), and the like as a combination of the input/output equipment.

[Embodiment 3]

The embodiment 3 of the invention will now be described in detail hereinbelow with reference to the drawings.

The embodiment 3 of the invention applied to a copying apparatus with a monitor for displaying an original image and a previewer having functions for a selection of an output portion, an edition of a color, and the like on a monitor screen will now be described. Fig. 7 shows a schematic constructional block diagram of such a copying apparatus. Fig. 8 shows a schematic block diagram showing an arrangement of functional blocks in Fig. 7. The same component elements in Figs. 7 and 8 are designated by the same reference numerals.

An image of an original is read by the image scanner 10. The image scanner 10 outputs the read image data as an RGB signal. The scanner color conversion device 12 converts the output signal of the RGB colorimetric system (color system) of the scanner 10 into the values of the XYZ colorimetric system in consideration of the reading characteristics of the image scanner 10 in accordance with the scanner profile 14 which has been prepared in accordance with the reading characteristics of the image scanner 10. An output of the color conversion device 12 is a standard color signal which doesn't depend on the image input device. It will be obviously understood that the standard color space is not limited to the XYZ colorimetric system and another arbitrary colorimetric system can be used so long as it can absorb a device dependence.

Data regarding the color characteristics of the scanner 10 has been stored in the scanner profile 14. Specifically speaking, a color conversion matrix from RGB to XYZ or a lookup table (LUT) has been stored.

The signal conversion device 16 corrects an output of the conversion device 12 in accordance with ambient color information which is supplied from the ambient light sensor 18 for detecting color components or a color distribution of the ambient light and white information and information of a background color of the monitor 24 to display the read image. In the embodiment, the white information and the information of the background color of the monitor 24 are supplied from the monitor profile 22 having the coloring characteristics of the monitor 24.

In accordance with the coloring characteristics information from the monitor profile 22, the monitor color conversion device 20 converts the output signal of the XYZ colorimetric system of the signal conversion device 16 into the RGB values in consideration of the coloring characteristics of the monitor 24 and supplies to the monitor 24. The monitor 24 displays the image of the original as a preview image.

Data regarding the coloring characteristics of the monitor 24, specifically speaking, a color temperature and a light emission luminance of the monitor 24, a chromaticity value of a fluorescent material, color conversion information from the standard color space to the device dependence color signal, and the like have been stored in the monitor profile 22. The monitor background color information which is supplied from the monitor profile 22 to the signal conversion device 16 includes background color information which is at present displayed by the monitor 24 and the background color information when the monitor profile 22 is formed.

In accordance with the characteristics information from a printer profile 28 having coloring characteristics of the printer 30, the printer color conversion device 26 converts the output signal of the XYZ colorimetric system of the signal conversion device 16 into CMYK signal in consideration of the coloring characteristics of the printer 30 and supplies to the printer 30. The printer 30 prints and outputs the image of the original onto a recording paper in accordance with the color signal from a color conversion device 26.

As shown in Fig. 8, the scanner color conversion device 12 is enclosed in a scanner unit 32. The signal conversion device 16, monitor color conversion device 20, printer color conversion device 26, and printer 30 are enclosed in a printer unit 34. The monitor 24 is put on an upper portion of the scanner unit 32. The ambient light sensor 18 is arranged beside the monitor 24.

Fig. 9 shows a schematic constructional block diagram in the signal conversion device 16. Adaptation ratios corresponding to one or two or more environments which are presumed in the case where the ambient light is a predetermined standard light source (A, C, D93, D65, D50, F, etc.) have been stored in an adaptation ratio storage 40. An adaptation ratio also corresponding to a background color (for example, gray scale) when an image is seen has also been stored in the adaptation ratio storage 40. An adaptation ratio determination device 42 selects the adaptation ratios corresponding to the present ambient light and the background color of the monitor from the adaptation ratio storage 40 in accordance with the ambient light information from the ambient light sensor 18 and the monitor white information and the monitor background color information from the monitor profile 22 and supplies to a reference white calculation device 44.

The reference white calculation device 44 calculates reference white suitable for the ambient light and an observation environment such as color temperature, background color, and the like of the monitor 24 in accordance with the adaptation ratios from the adaptation ratio determination device 42, the ambient light information from the ambient light sensor 18, and the monitor white information and monitor background color information from the monitor profile 22. Its calculating method will be described in detail hereinlater.

An image conversion device 46 converts signals (Xi, Yi, Zi) from the scanner color conversion device 12 in accordance with reference white (Xw, Yw, Zw, xw, yw) calculated by the reference white calculation device 44 and gen-

erates signals (Xo, Yo, Zo) of the XYZ colorimetric system.

Fig. 10 is a schematic diagram showing the relations among the ambient light, white and background color of the monitor, and reference white. The ambient light is based on the reference light source. Fig. 10 shows reference white colors as an example with respect to two background colors. An output of the ambient light sensor 18 can be any one of the spectral data, color signals of XYZ, RGB, or the like, and manual input of those color signals. In Fig. 10, the ambient light information is shown as a reference light source W. The monitor white information from the monitor profile 22 is the color temperature, luminance value, chromaticity value, etc. and is shown as a monitor white point V in Fig. 10.

As described above, when observing the image which is displayed on the monitor screen, it is considered that the human being isn't perfectly adaptive to only monitor white but is adaptive to both of monitor white and the ambient light at a certain ratio. As shown in Fig. 10. therefore, reference white serving as a color observing reference is located between monitor white and the ambient light (reference light source). It is now assumed that an adaptation ratio to monitor white is set to s, an adaptation ratio to the ambient light is set to 1-s, the ambient light information which is obtained from the ambient light sensor 18 is set to Wx, Wy, Wz, wx and wy, monitor white signals which are obtained from the monitor profile 22 are set to Vx, Vy, Vz, vx, and vy, and reference white signals to be calculated are set to Xw, Yw, Zw, xw, and yw, respectively. Thus, Xw, Yw, Zw, xw, and yw can be calculated by the following equations (1) and (2). Namely, with regard to three stimulus values,

$$\begin{aligned} Xw &= (1-s)\cdot Wx + s\cdot Vx \\ Yw &= (1-s)\cdot Wy + s\cdot Vy \\ Zw &= (1-s)\cdot Wz + s\cdot Vz \end{aligned} \qquad \cdots (1)$$

With regard to the chromaticity values,

$$\begin{aligned} xw &= (1-s)\cdot wx + s\cdot vx \\ yw &= (1-s)\cdot wy + s\cdot vy \end{aligned} \qquad (2)$$

Since s depends on the ambient light at the time of the image observation and the background color of the monitor 24. the adaptation ratio (s : 1-s) changes depending on the ambient light and the background color of the image. In association with it. the reference white point also changes every ambient light and background color. For example, when the background color is changed from black to white at a gray scale level, as the background color approaches black, the adaptation ratio to the ambient light increases irrespective of the color temperature of the monitor 24 and ambient light.

It is, therefore, necessary to decide the adaptation ratio in accordance with not only the ambient light but also the background color to be observed. In the embodiment, by deciding as mentioned above, the optimum reference white point is calculated.

A method of converting the whole image on the basis of the reference white signal calculated in this manner will now be described.

The image which is displayed on the monitor screen is observed on the basis of reference white calculated as mentioned above. On the other hand, the printed matter is adaptive to white of the paper or white of the ambient light. It is now assumed that the reference white is set to Xw. Yw, and Zw, white of the ambient light is set to Wx, Wy, and Wz, the image signals (input signals of the image conversion device) which are inputted from the scanner color conversion device 12 to the signal conversion device 16 are set to Xi, Yi, and Zi, and the image signals which are outputted from the image conversion device 46 of the signal converting apparatus are set to Xo, Yo, and Zo. The following equation (3) as a modification of Von Kreis's equation is satisfied. Namely,

$$\begin{bmatrix} Xo / Xw \\ Yo / Yw \\ Zo / Zw \end{bmatrix} = \begin{bmatrix} Xi / Wx \\ Yi / Wy \\ Zi / Wz \end{bmatrix} \qquad \cdots (3)$$

By modifying the equation (3), the following equation (4) is obtained.

$$\begin{bmatrix} Xo \\ Yo \\ Zo \end{bmatrix} = \begin{bmatrix} Xi \\ Yi \\ Zi \end{bmatrix} \begin{bmatrix} Xw / Wx \\ Yw / Wy \\ Zw / Wz \end{bmatrix} \quad \ldots (4)$$

The following equation (5) can be also used by also including the contrast conversion of the image in consideration of the visual sense characteristics of the human being into the equation (4). Namely,

$$\begin{bmatrix} Xo / Xw \\ Yo / Yw \\ Zo / Zw \end{bmatrix} = \begin{bmatrix} Xi / Wx \\ Yi / Wy \\ Zi / Wz \end{bmatrix}^{\gamma} \quad \ldots (5)$$

By modifying the equation (5),

$$\begin{bmatrix} Xo \\ Yo \\ Zo \end{bmatrix} = \begin{bmatrix} Xi / Wx \\ Yi / Wy \\ Zi / Wz \end{bmatrix}^{\gamma} \begin{bmatrix} Xw \\ Yw \\ Zw \end{bmatrix} \quad \ldots (6)$$

The monitor color conversion device 20 converts the image signals Xo, Yo, and Zo obtained as mentioned above from the XYZ colorimetric system to the RGB colorimetric system in accordance with the conversion information from the monitor profile 22.

By such a color matching process, color tones of a source image and an output image can be matched. Particularly, by obtaining the reference white signal also in consideration of the background color, a good color matching process can be performed.

In the above embodiment, when the adaptation ratio (s : 1-s) or s is decided, the adaptation ratio has been changed in accordance with both of the ambient light and the background color. However, the adaptation ratio can be also set in accordance with the observation environment such as color temperature of the monitor, reflected light from the monitor, or the like.

Fig. 11 shows a schematic constructional block diagram of a modification of the above embodiment. In the modification, the user can select the setting of a color process. Specifically speaking, in case of performing the color process at a high precision, a predetermined background color is displayed on the monitor 24 and both of the display image and the background color, namely, the whole screen of the monitor 24 is controlled, thereby more accurately matching the original image to be displayed on the monitor 24 and the original image which is seen. Reference numeral 50 denotes a color processing setting device to set a color processing method. There are a mode to use the present background color of the monitor 24 as it is and a mode to display a specific background color which has previously been selected. The user selects the latter mode when he wants to perform a color management at a high accuracy.

Fig. 12 shows a flowchart of a main operation portion of the modification shown in Fig. 11.

By the color processing setting device 50, the user sets the color processing method (color matching mode) to be executed by the signal conversion device 16 in accordance with an application (S1). It can be set by a menu bar or the like or can be also selected by pushing a button. Further, it is also possible to determine the default in a manner such that the color managing process as described in the embodiment shown in Fig. 7 is performed and a highly-

accurate color management is executed in the other cases.

In case of the highly-accurate color management (S1), the background color of the screen of the monitor 24 is set to a predetermined color (S5). In the case where the highly-accurate color management is not performed (in case of the ordinary color management) (S1), the present background color is maintained as it is.

In order to perform the highly-accurate color management, it is necessary to control the background color. Therefore, when a plurality of windows are opened on the same screen, the other windows are hidden by the background color. On the other hand, when the highly-accurate color management is not performed, processes can be executed in parallel with reference to the other windows. The user, accordingly, sets the color processing method on the basis of the application (whether a priority is given to the precision of the color matching or not) in step S1.

The subsequent processes are substantially the same as those in the embodiment shown in Fig. 7. The signal conversion device 16 sets the optimum adaptation ratio from the ambient light information from the ambient light sensor 18, the monitor white information, and the background color of the monitor and converts the output signal of the scanner color conversion device 12 in accordance with the reference white signal that is decided on the basis of the adaptation ratio (S2). The monitor color conversion device 20 converts the output signal of the signal conversion device 18 from the XYZ colorimetric system to the RGB colorimetric system (S3). The output image signal of the monitor color conversion device 20 is displayed at a predetermined position on the screen of the monitor 24 (S4).

In case of the highly-accurate color management, since the background color is a predetermined color, the color matching can be performed at a higher accuracy. As a background color in this case, for example, a background color which has been set in the environment at the time of the formation of the profile or a standard environment at the time of the color observation or a background color that is optimum to every environment has been prepared and the proper background color is selected among them in accordance with the present environment.

In the modification shown in Fig. 11, the decided background color has been displayed only in case of selecting the highly-accurate color management process. However, it is also possible to enable whether the color management is performed or not to be selected and to automatically display the determined background color in case of executing the color management.

As for the background color of the monitor when the image is observed, the standard observing condition at the time of the formation of the profile can be determined and such information can be stored into the profile as mentioned above. However, in any case, it will be understood that when a luminance of the background color to be displayed on the monitor is lower than that of white in the observation image (white in the print original), it is more desirable in case of matching both of the colors. White in the observation image (white in the print original) is obtained from a reflectance of the paper which has previously been known and the light source information derived from the ambient light sensor 18. When the luminance of white in the print image is equal to or less than the luminance of the highest output of the monitor, it is desirable to use the luminance of the background color having a value smaller than that of white in the observation image.

For example, when the image is observed in an environment in which the luminance of white in the observation image and the highest luminance of the monitor are equal and, after that, the luminance of the ambient light of the room decreases, a phenomenon such that both of the colors cannot be matched because the background color of the monitor is too bright occurs. However, by setting the luminance of the monitor background color to be lower than that of white in the observation image, an environment in which the color matching is more available can be formed.

As means for obtaining the ambient light information, it is possible to detect the ambient light of the environment in which the image is at present observed by a sensor or to previously measure the ambient light by the user by using an illumination photometer, a luminance meter, or the like and to input the measured value to the signal conversion device 16. It is also possible to use a method whereby several selection items have already been made and a proper value that is closest to the present environment is selected among them.

By calculating white in the observation image from the ambient light information obtained and the well-known reflectance of the paper and by changing the background color of the monitor so that the luminance of the background color is lower than that of such white, both of the colors can be matched.

The invention is not limited to the above embodiment. For example, the invention can be applied to the color signal conversions of various input/output equipment. Namely, the invention can be used in every image processing apparatus for performing the color signal conversion.

It will be obviously understood that the monitor display is not limited to the CRT display but can also use a liquid crystal display.

According to the embodiment 3 and its modification as described above, in the correction to match the light source color and the observation color of the object color, the reference white is calculated on the basis of not only the ambient light but also the background color in case of observing the image and the whole image is converted in accordance with the calculated reference white. Therefore, the observation color of the display image can be also matched to a different background color.

By forcedly setting the background color to a predetermined color, the observation color can be more accurately

matched.

By setting the luminance of the background color to be lower than that of white of the image (white in the print image), both of the colors can be matched.

By performing the color temperature conversion by reference white suitable for the observation environment, the color tones can be preferably matched.

A highly-accurate color matching can be provided on the basis of an application of the user.

<Other embodiments>

The invention can be applied to a system constructed by a plurality of equipment (for example, a host computer, an interface equipment, a reader, a printer, or the like) or can be also applied to an apparatus comprising one equipment (for example, a copying apparatus or a facsimile apparatus).

An invention embodied by a method whereby program codes of a software to realize the functions of the embodiment are supplied to a computer in an apparatus or system connected to various devices so as to make the devices operative in order to realize the functions of the foregoing embodiments and the various devices are operated in accordance with the programs stored in the computer (CPU or MPU) of the system or apparatus is also included in the scope of the invention.

In such a case, the program codes themselves of the software realize the functions of the foregoing embodiments and the program codes themselves and means for supplying the program codes to the computer, for example, a memory medium in which the program codes have been stored construct the invention.

As such a memory medium to store the program codes, for example, it is possible to use a floppy disk, a hard disk, an optical disk, a magnetooptic disk, a CD-ROM, a magnetic tape, a non-volatile memory card, an ROM, or the like can be used.

It will be obviously understood that the program codes are included in the embodiments of the invention even in not only a case where the functions of the foregoing embodiments are realized by executing the supplied program codes by the computer but also a case where the functions of the foregoing embodiments are realized in cooperation with the OS (operating system) by which the program codes operate in the computer or another application software or the like.

Further, it will be also obviously understood that the invention also incorporates a case where the supplied program codes are stored into a memory provided for a function expansion board of a computer or a function expansion unit connected to a computer and, after that, a CPU or the like provided for the function expansion board or function expansion unit executes a part or all of the actual processes on the basis of instructions of the program codes, and the functions of the foregoing embodiments are realized by the processes.

Although the present invention has been described above with respect to the preferred embodiments, the invention is not limited to the foregoing embodiments but many modifications and variations are possible within the spirit and scope of the appended claims of the invention.

Claims

1. An image processing apparatus comprising:

   setting means for manually setting a first color processing parameter;
   first color processing means for performing a first color process by using said first color processing parameter;
   storing means for storing a second color processing parameter set in correspondence to said first color processing parameter as a reference value; and
   second color processing means for performing a second color process different from said first color process by using said second color processing parameter,
   wherein in case of making said second color processing means function, said first color processing parameter is set to said reference value.

2. An apparatus according to claim 1, wherein on the basis of characteristics of an input unit or an output unit, said second color processing means executes said second color process by using said second color processing parameter so as to reproduce an image at a high fidelity.

3. An apparatus according to claim 1, further having resetting means for resetting said first color processing parameter corresponding to output means when an output image derived by said second color process cannot be satisfied,

and wherein said first color processing means executes said first color process to the image data which was subjected to said second color process on the basis of said reset first color processing parameter, and said resetting process and the first color process based on said first color processing parameter set by said resetting means are repetitively executed until the output image can be satisfied.

4. An apparatus according to claim 1, wherein said storing means stores said second color processing parameter and said reference value so as to correspond to each other.

5. An image processing apparatus having first and second color matching modes for performing different color matching processes, comprising:

selecting means for selecting the color matching mode on the basis of an instruction of a user; and
setting means for setting a background color on a display screen to a predetermined color when said second color matching mode is selected by said selecting means.

6. An apparatus according to claim 5, further comprising:

storing means for storing a profile according to said background color; and
color matching processing means for performing the color matching process by using said profile.

7. An apparatus according to claim 5, wherein in said color matching process, a color adapting process according to said background color and an illumination light to illuminate said display screen is executed.

8. An image processing method comprising:

a setting step of manually setting a first color processing parameter;
a first color processing step of performing a first color process by using said first color processing parameter;
a storing step of storing a second color processing parameter set in correspondence to said first color processing parameter as a reference value; and
a second color processing step of performing a second color process different from said first color process by using said second color processing parameter,
wherein in case of making said second color processing means function, said first color processing parameter is set to said reference value.

9. A recording medium to store programs to realize an image processing method comprising:

a setting step of manually setting a first color processing parameter;
a first color processing step of performing a first color process by using said first color processing parameter;
a storing step of storing a second color processing parameter set in correspondence to said first color processing parameter as a reference value; and
a second color processing step of performing a second color process different from said first color process by using said second color processing parameter,
wherein in case of making said second color processing means function, said first color processing parameter is set to said reference value.

10. An image processing method having first and second color matching modes for performing different color matching processes, comprising:

a selecting step of selecting the color matching mode on the basis of an instruction of a user; and
a setting step of setting a background color on a display screen to a predetermined color when said second color matching mode is selected by said selecting step.

11. A recording medium to store programs to realize an image processing method having first and second color matching modes for performing different color matching processes, comprising:

a selecting step of selecting the color matching mode on the basis of an instruction of a user; and
a setting step of setting a background color on a display screen to a predetermined color when said second color matching mode is selected by said selecting step.

FIG. 1

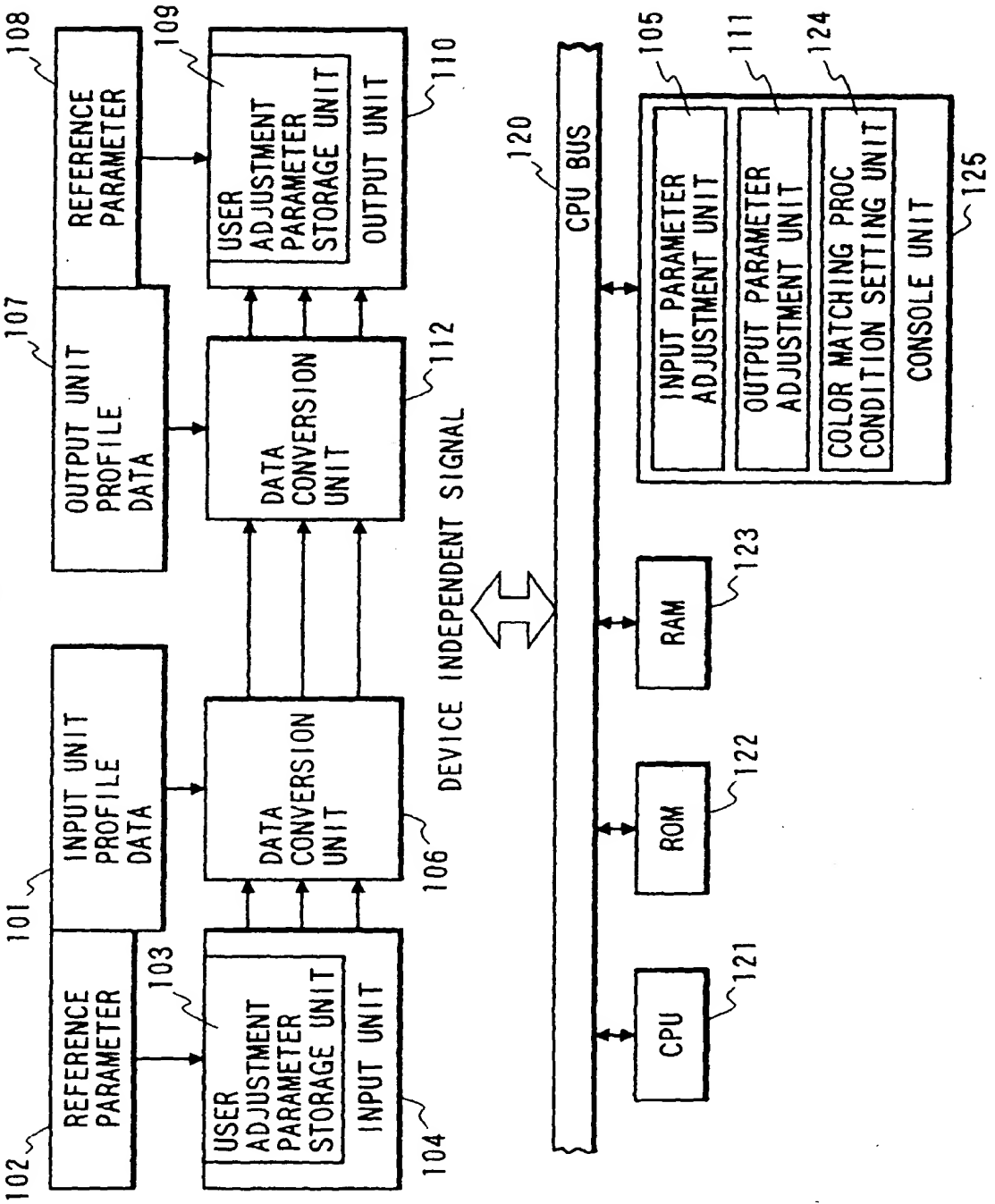

101
INPUT UNIT PROFILE DATA
102
REFERENCE PARAMETER
103
USER ADJUSTMENT PARAMETER STORAGE UNIT
104
INPUT UNIT
106
DATA CONVERSION UNIT
107
OUTPUT UNIT PROFILE DATA
108
REFERENCE PARAMETER
109
USER ADJUSTMENT PARAMETER STORAGE UNIT
110
OUTPUT UNIT
112
DATA CONVERSION UNIT
DEVICE INDEPENDENT SIGNAL
120
CPU BUS
121
CPU
122
ROM
123
RAM
105
INPUT PARAMETER ADJUSTMENT UNIT
111
OUTPUT PARAMETER ADJUSTMENT UNIT
124
COLOR MATCHING PROC CONDITION SETTING UNIT
125
CONSOLE UNIT

FIG. 2

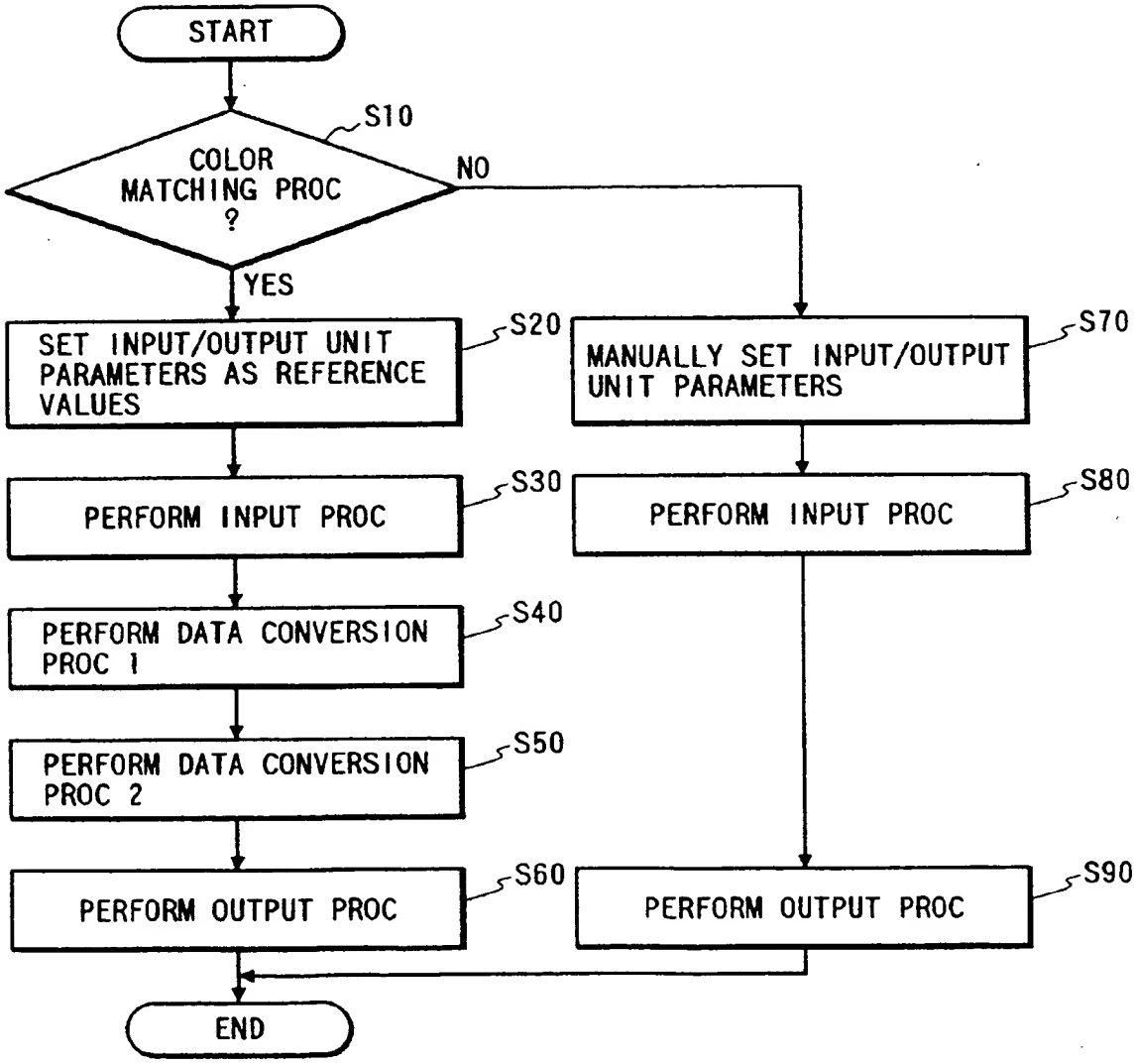

START
S10
COLOR MATCHING PROC ?
NO
YES
SET INPUT/OUTPUT UNIT PARAMETERS AS REFERENCE VALUES
S20
MANUALLY SET INPUT/OUTPUT UNIT PARAMETERS
S70
PERFORM INPUT PROC
S30
PERFORM INPUT PROC
S80
PERFORM DATA CONVERSION PROC 1
S40
PERFORM DATA CONVERSION PROC 2
S50
PERFORM OUTPUT PROC
S60
PERFORM OUTPUT PROC
S90
END

FIG. 3

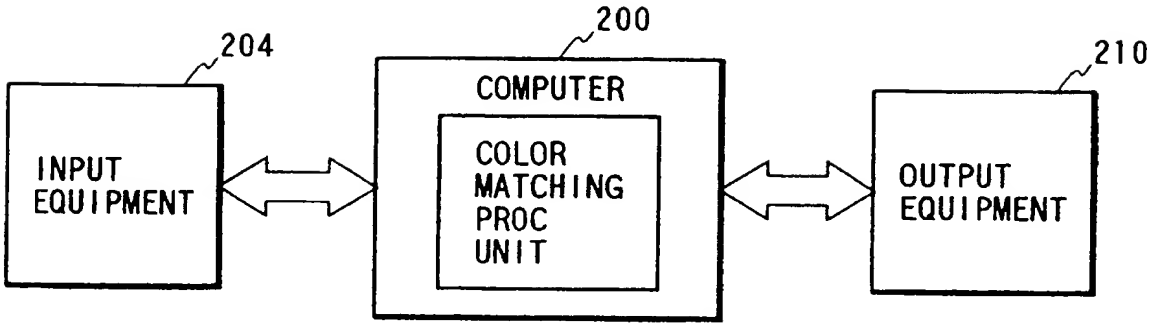

204
200
210
COMPUTER
INPUT EQUIPMENT
COLOR MATCHING PROC UNIT
OUTPUT EQUIPMENT

FIG. 4

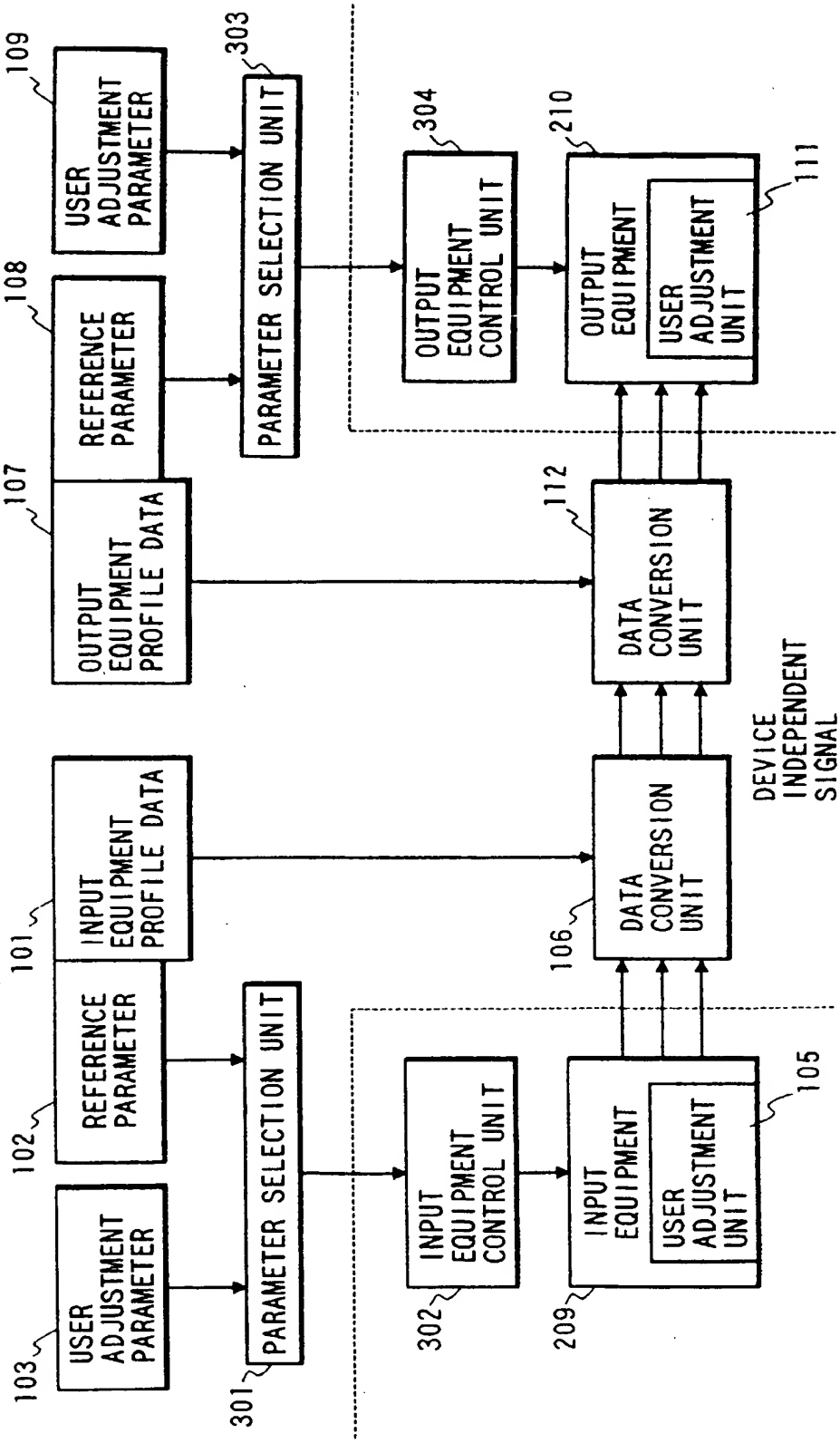

INPUT EQUIPMENT PROFILE DATA
101
REFERENCE PARAMETER
102
USER ADJUSTMENT PARAMETER
103
PARAMETER SELECTION UNIT
301
INPUT EQUIPMENT CONTROL UNIT
302
INPUT EQUIPMENT
USER ADJUSTMENT UNIT
209
105
DATA CONVERSION UNIT
106
DEVICE INDEPENDENT SIGNAL
OUTPUT EQUIPMENT PROFILE DATA
107
REFERENCE PARAMETER
108
USER ADJUSTMENT PARAMETER
109
PARAMETER SELECTION UNIT
303
OUTPUT EQUIPMENT CONTROL UNIT
304
OUTPUT EQUIPMENT
USER ADJUSTMENT UNIT
210
111
DATA CONVERSION UNIT
112

FIG. 5

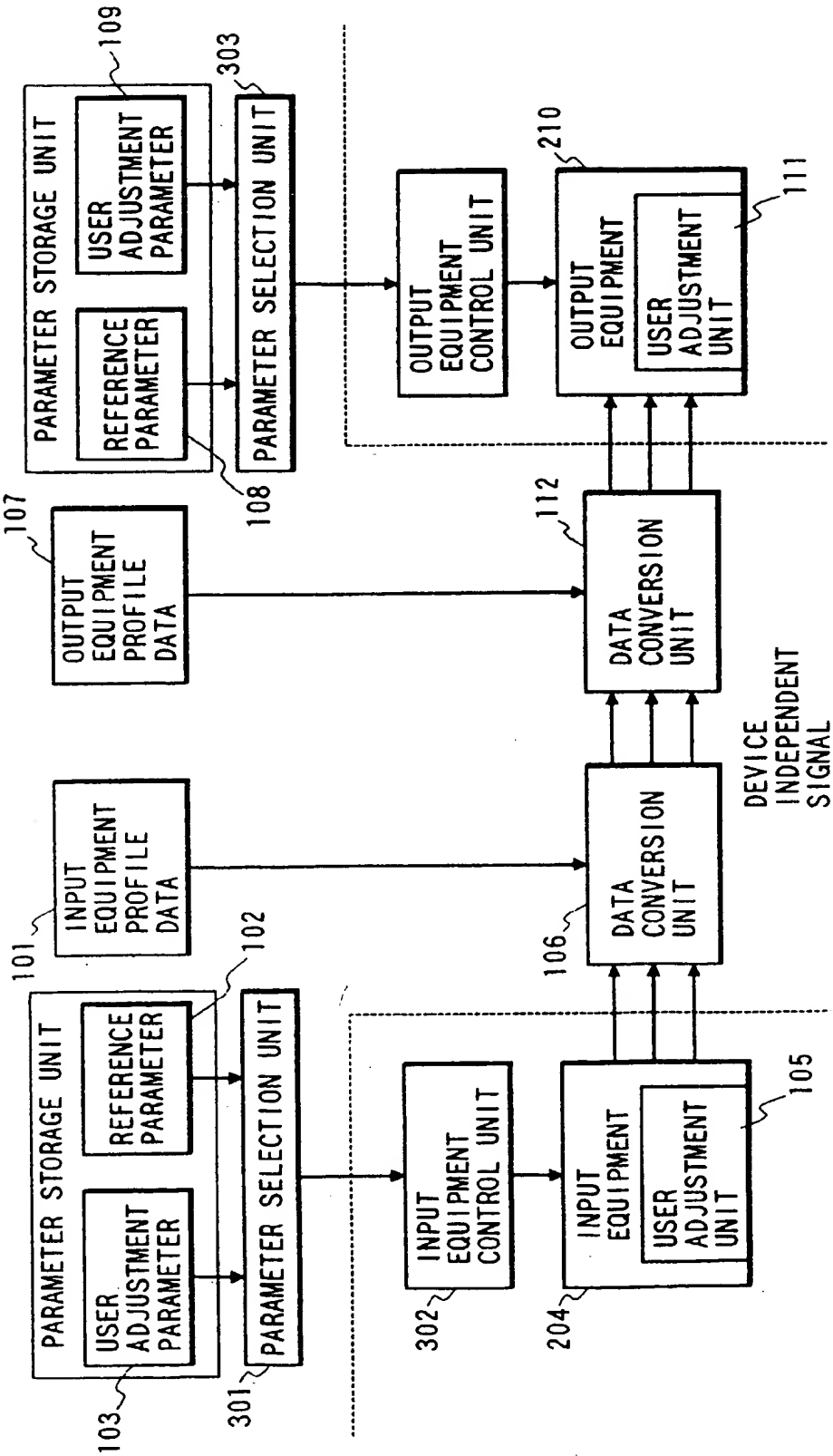

PARAMETER STORAGE UNIT
USER ADJUSTMENT PARAMETER
REFERENCE PARAMETER
PARAMETER SELECTION UNIT
OUTPUT EQUIPMENT CONTROL UNIT
OUTPUT EQUIPMENT
USER ADJUSTMENT UNIT
OUTPUT EQUIPMENT PROFILE DATA
DATA CONVERSION UNIT
INPUT EQUIPMENT PROFILE DATA
DATA CONVERSION UNIT
DEVICE INDEPENDENT SIGNAL
PARAMETER STORAGE UNIT
REFERENCE PARAMETER
USER ADJUSTMENT PARAMETER
PARAMETER SELECTION UNIT
INPUT EQUIPMENT CONTROL UNIT
INPUT EQUIPMENT
USER ADJUSTMENT UNIT
109
303
210
111
107
112
108
101
102
106
103
301
302
204
105

FIG. 6

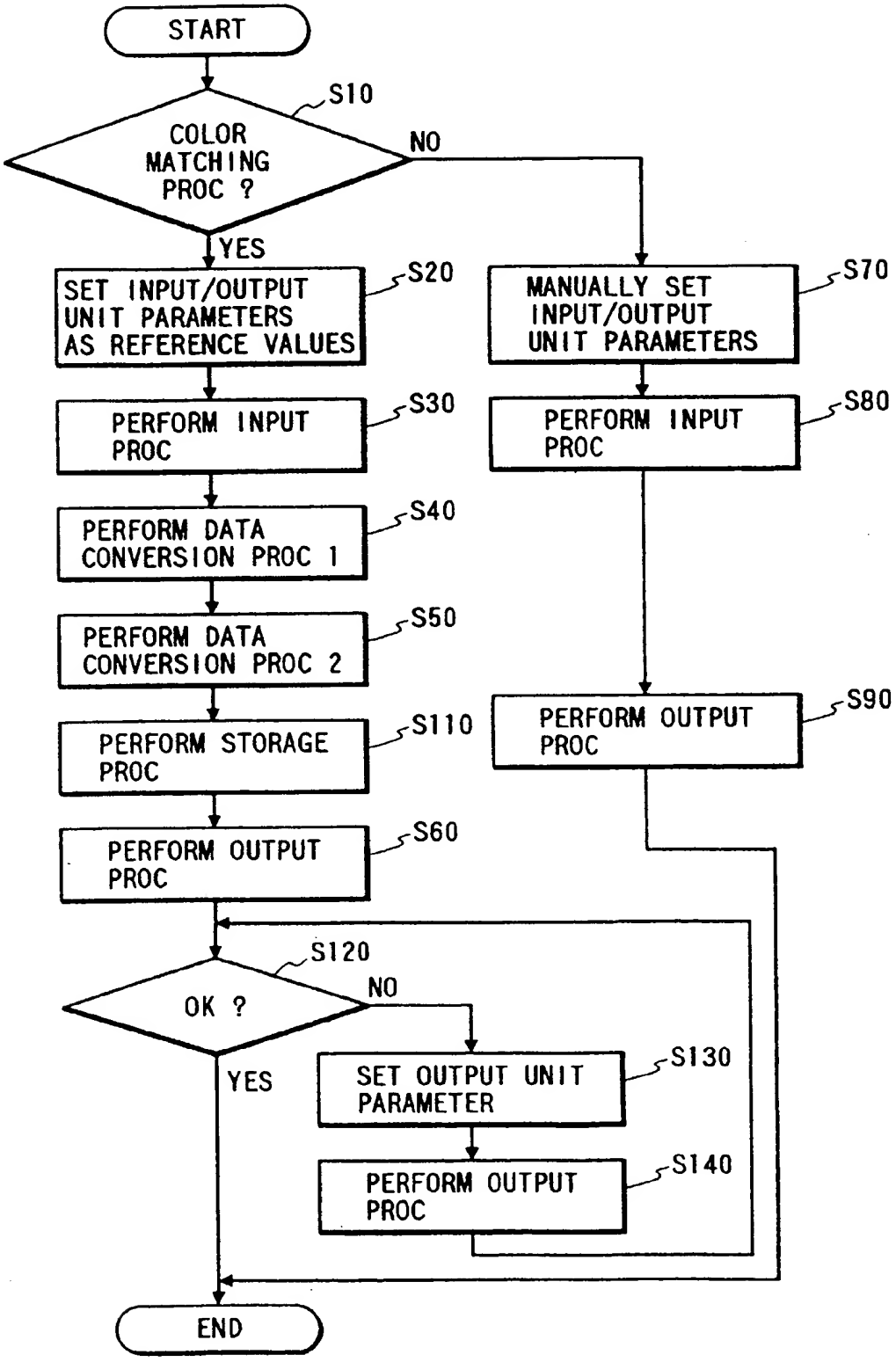

START
S10
COLOR MATCHING PROC ?
NO
YES
SET INPUT/OUTPUT UNIT PARAMETERS AS REFERENCE VALUES
S20
PERFORM INPUT PROC
S30
PERFORM DATA CONVERSION PROC 1
S40
PERFORM DATA CONVERSION PROC 2
S50
PERFORM STORAGE PROC
S110
PERFORM OUTPUT PROC
S60
MANUALLY SET INPUT/OUTPUT UNIT PARAMETERS
S70
PERFORM INPUT PROC
S80
PERFORM OUTPUT PROC
S90
S120
OK ?
NO
YES
SET OUTPUT UNIT PARAMETER
S130
PERFORM OUTPUT PROC
S140
END

FIG. 7

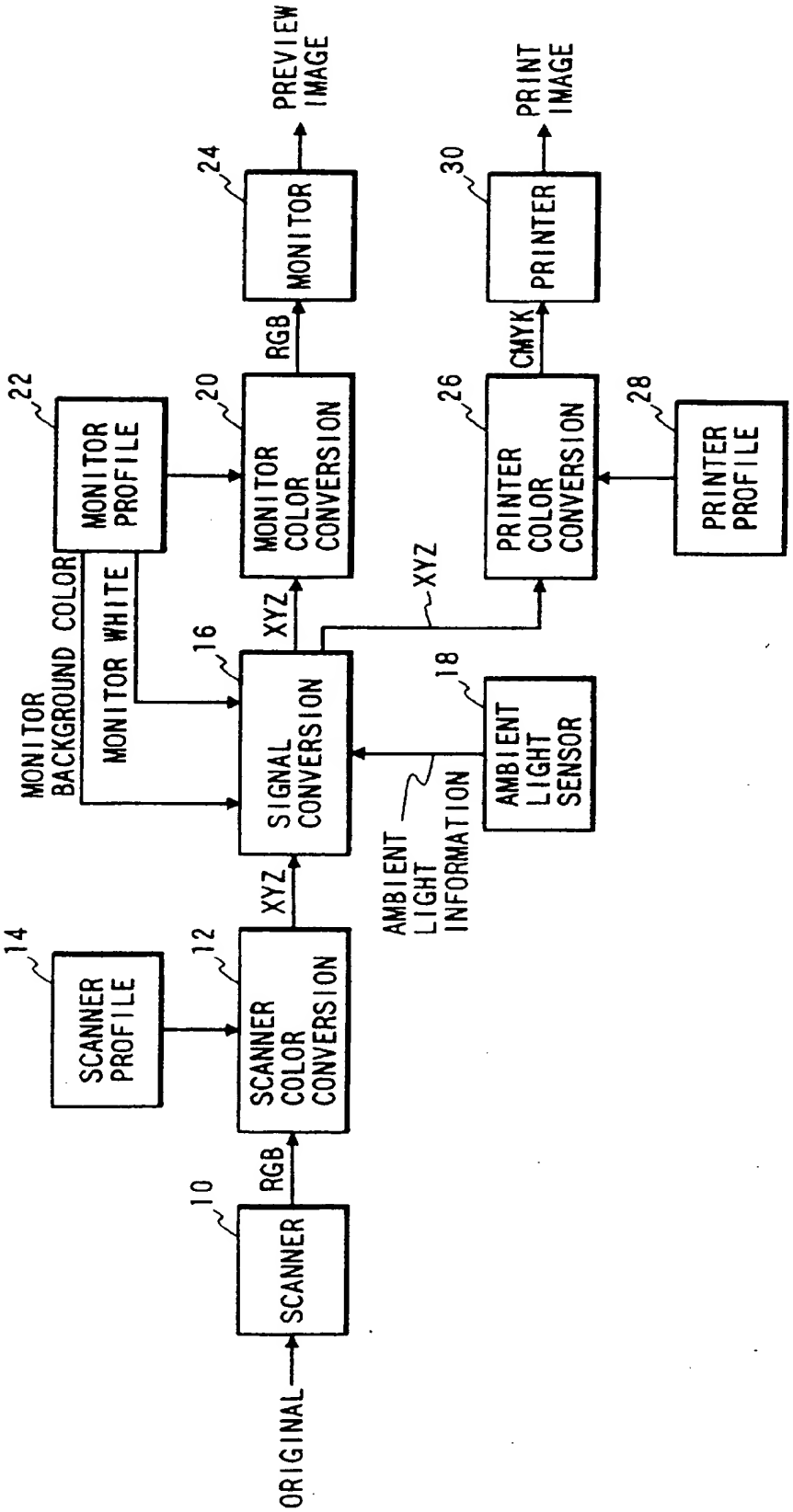

ORIGINAL
SCANNER
10
RGB
SCANNER COLOR CONVERSION
12
SCANNER PROFILE
14
XYZ
SIGNAL CONVERSION
16
AMBIENT LIGHT INFORMATION
AMBIENT LIGHT SENSOR
18
MONITOR BACKGROUND COLOR
MONITOR WHITE
MONITOR PROFILE
22
XYZ
MONITOR COLOR CONVERSION
20
RGB
MONITOR
24
PREVIEW IMAGE
XYZ
PRINTER COLOR CONVERSION
26
PRINTER PROFILE
28
CMYK
PRINTER
30
PRINT IMAGE

FIG. 8

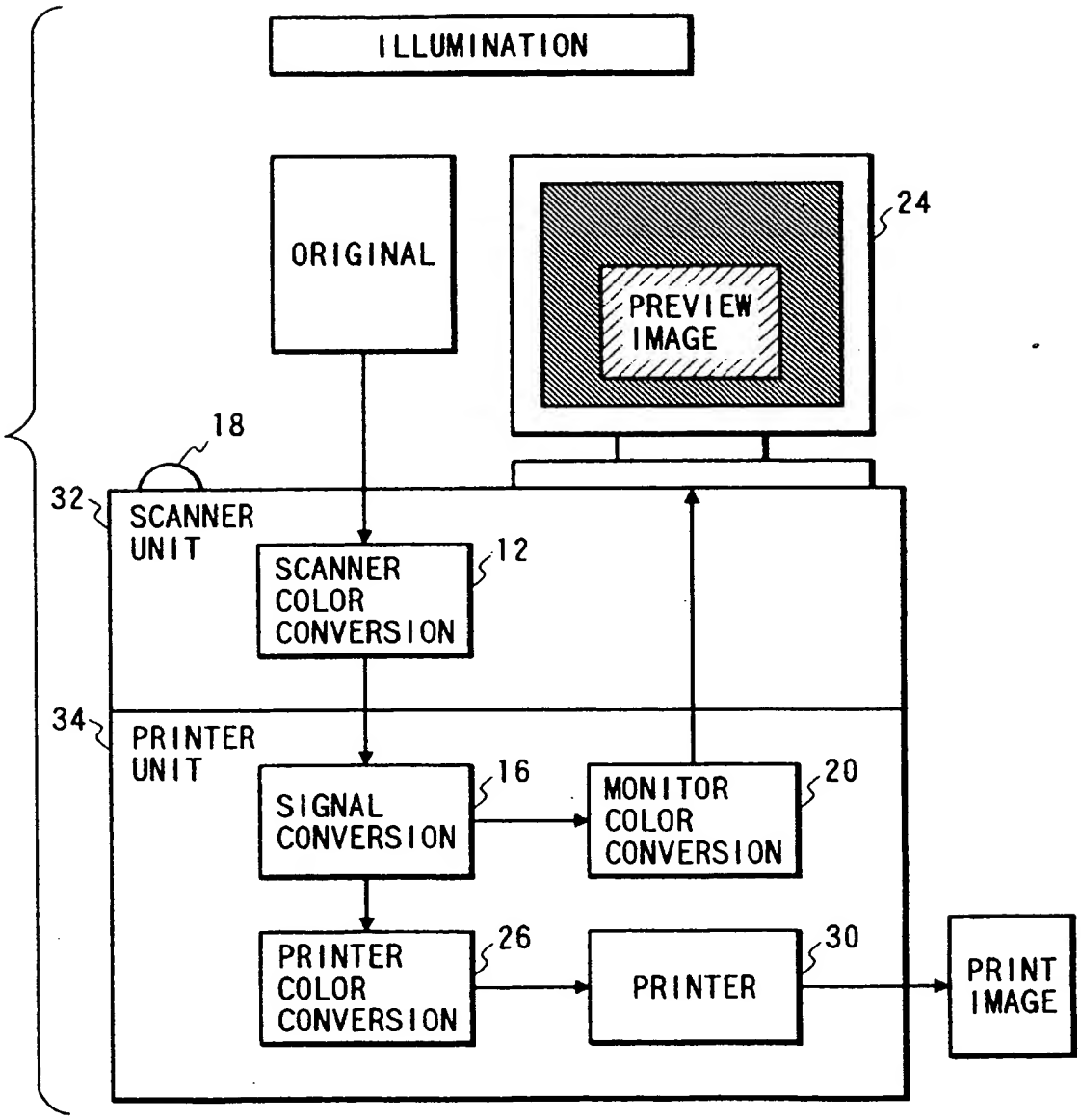

ILLUMINATION
ORIGINAL
PREVIEW IMAGE
24
18
32
SCANNER UNIT
SCANNER COLOR CONVERSION
12
34
PRINTER UNIT
SIGNAL CONVERSION
16
MONITOR COLOR CONVERSION
20
PRINTER COLOR CONVERSION
26
PRINTER
30
PRINT IMAGE

FIG. 9

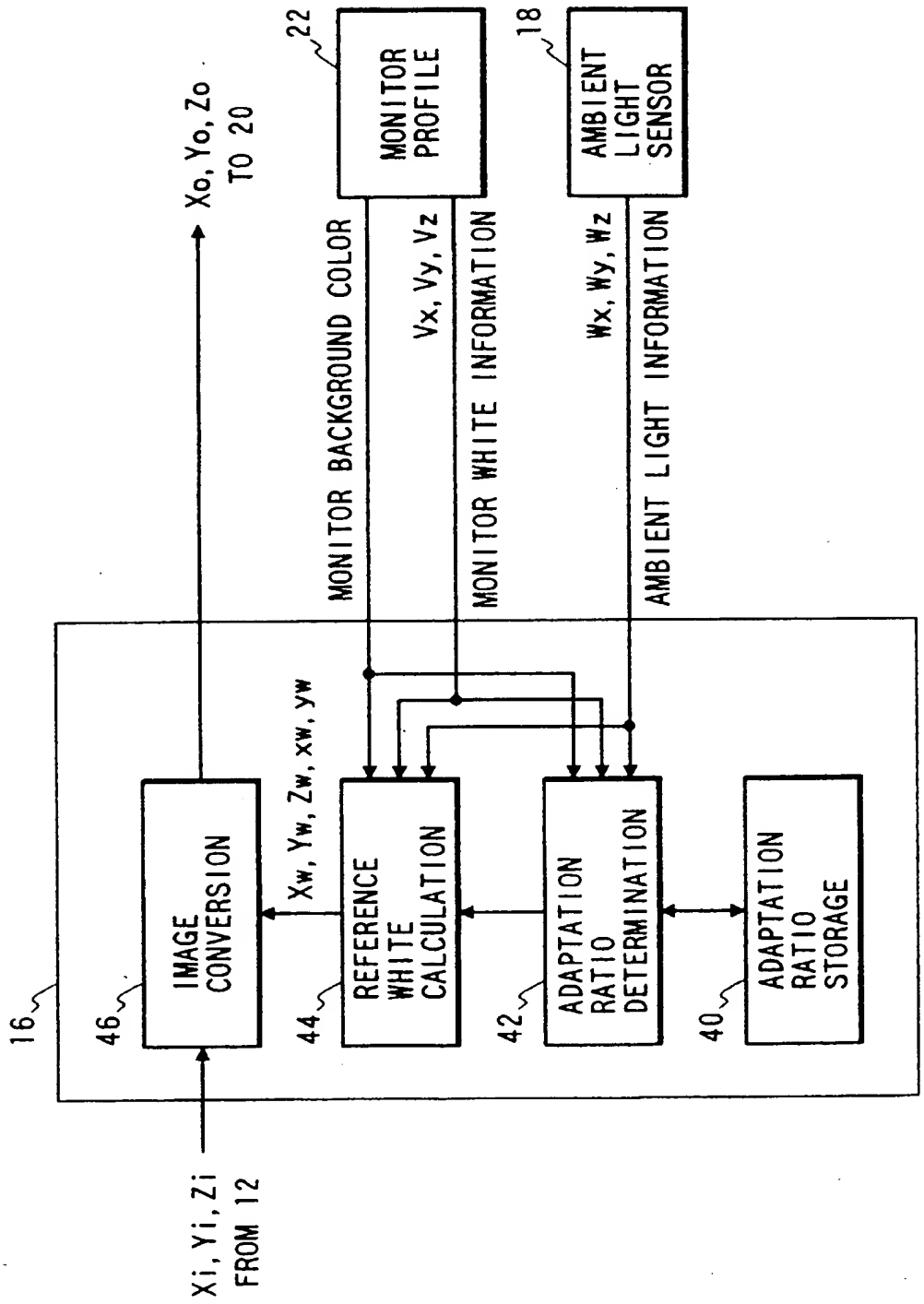

Xi, Yi, Zi
FROM 12
16
IMAGE CONVERSION
46
REFERENCE WHITE CALCULATION
44
ADAPTATION RATIO DETERMINATION
42
ADAPTATION RATIO STORAGE
40
Xw, Yw, Zw, xw, yw
Xo, Yo, Zo
TO 20
MONITOR PROFILE
22
AMBIENT LIGHT SENSOR
18
MONITOR BACKGROUND COLOR
Vx, Vy, Vz
MONITOR WHITE INFORMATION
Wx, Wy, Wz
AMBIENT LIGHT INFORMATION

FIG. 10

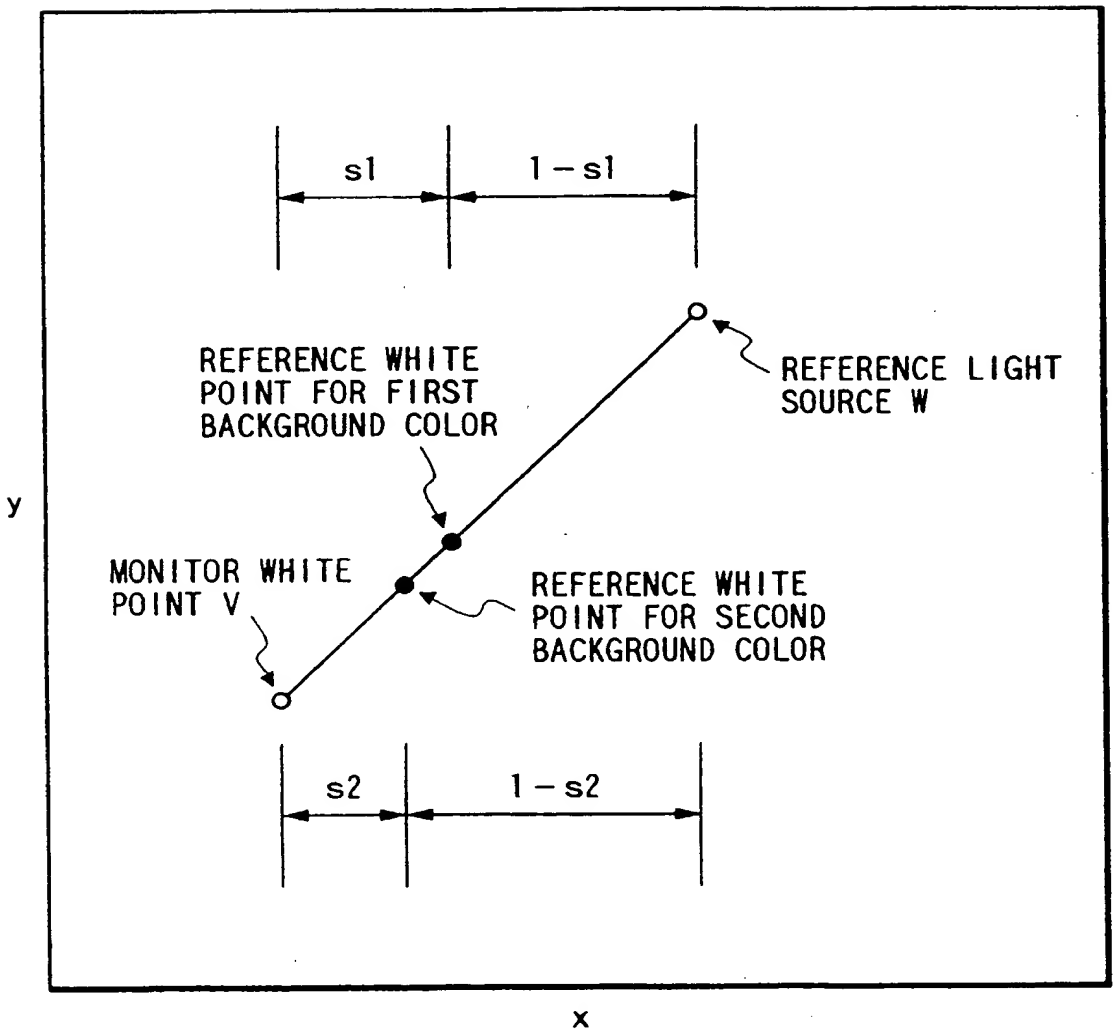

s1
1 − s1
REFERENCE WHITE POINT FOR FIRST BACKGROUND COLOR
REFERENCE LIGHT SOURCE W
y
MONITOR WHITE POINT V
REFERENCE WHITE POINT FOR SECOND BACKGROUND COLOR
s2
1 − s2
x

FIG. 11

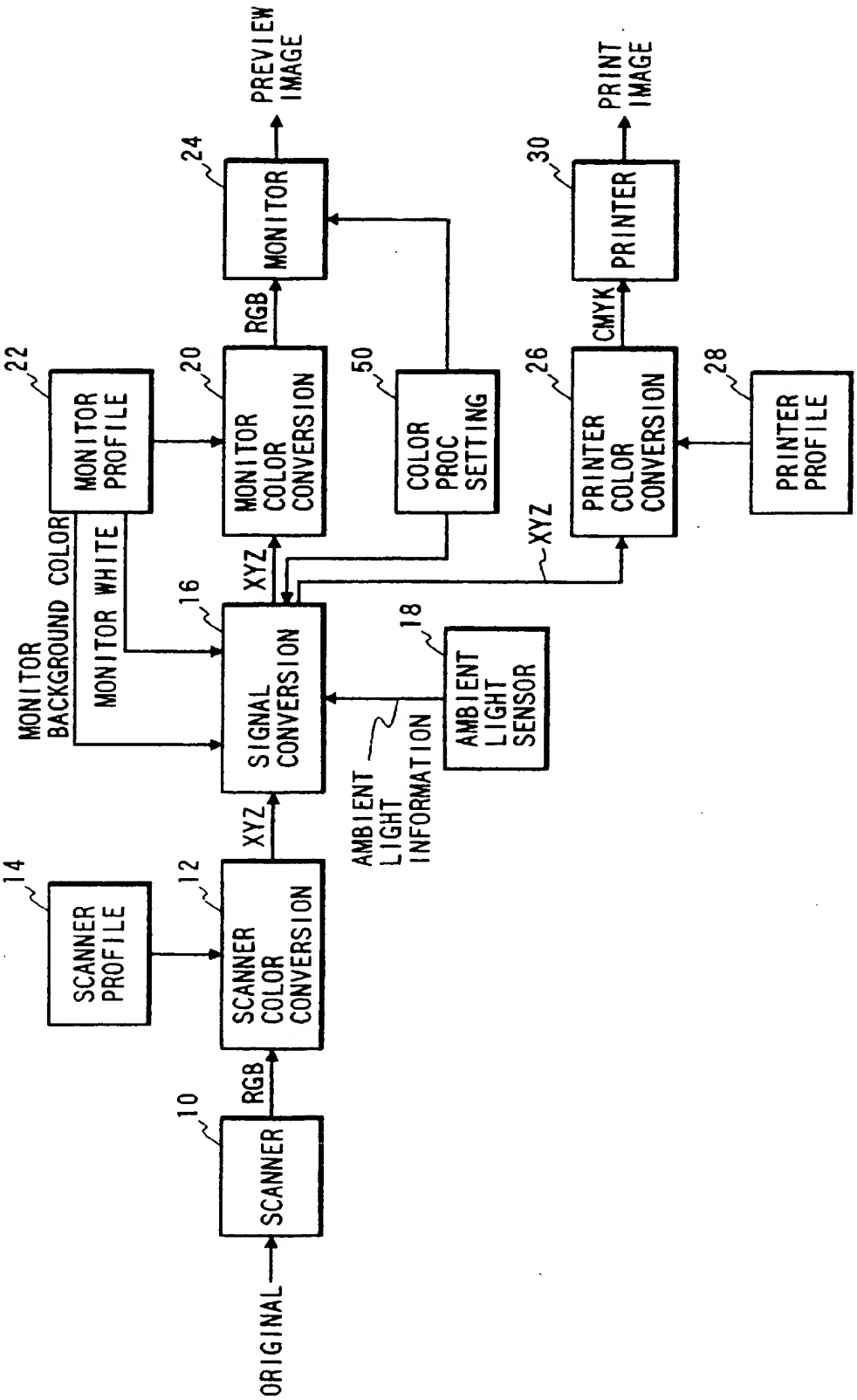

ORIGINAL
SCANNER
10
RGB
SCANNER COLOR CONVERSION
12
SCANNER PROFILE
14
XYZ
SIGNAL CONVERSION
16
AMBIENT LIGHT INFORMATION
AMBIENT LIGHT SENSOR
18
MONITOR BACKGROUND COLOR
MONITOR WHITE
MONITOR PROFILE
22
MONITOR COLOR CONVERSION
20
RGB
MONITOR
24
PREVIEW IMAGE
COLOR PROC SETTING
50
XYZ
PRINTER COLOR CONVERSION
26
CMYK
PRINTER
30
PRINT IMAGE
PRINTER PROFILE
28

FIG. 12

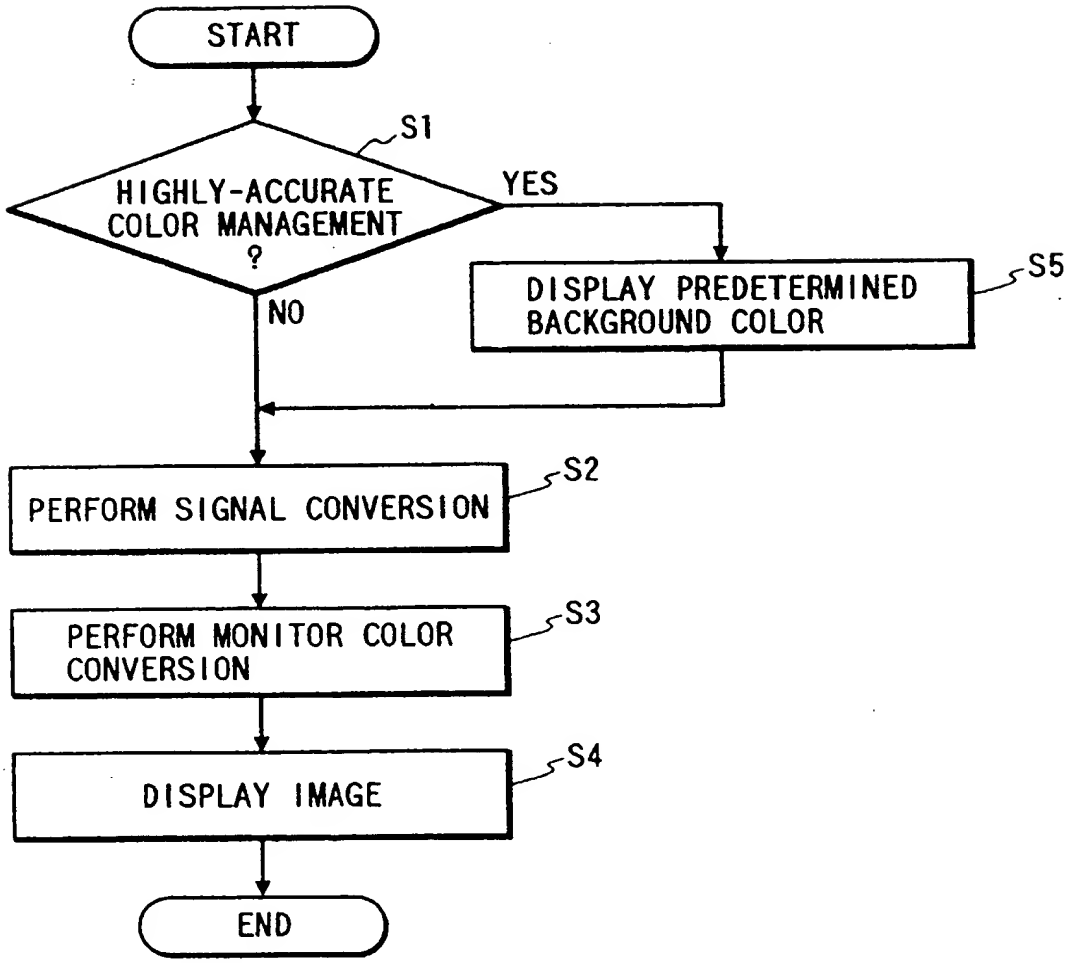

START
S1
HIGHLY-ACCURATE COLOR MANAGEMENT ?
YES
NO
DISPLAY PREDETERMINED BACKGROUND COLOR
S5
PERFORM SIGNAL CONVERSION
S2
PERFORM MONITOR COLOR CONVERSION
S3
DISPLAY IMAGE
S4
END

FIG. 13

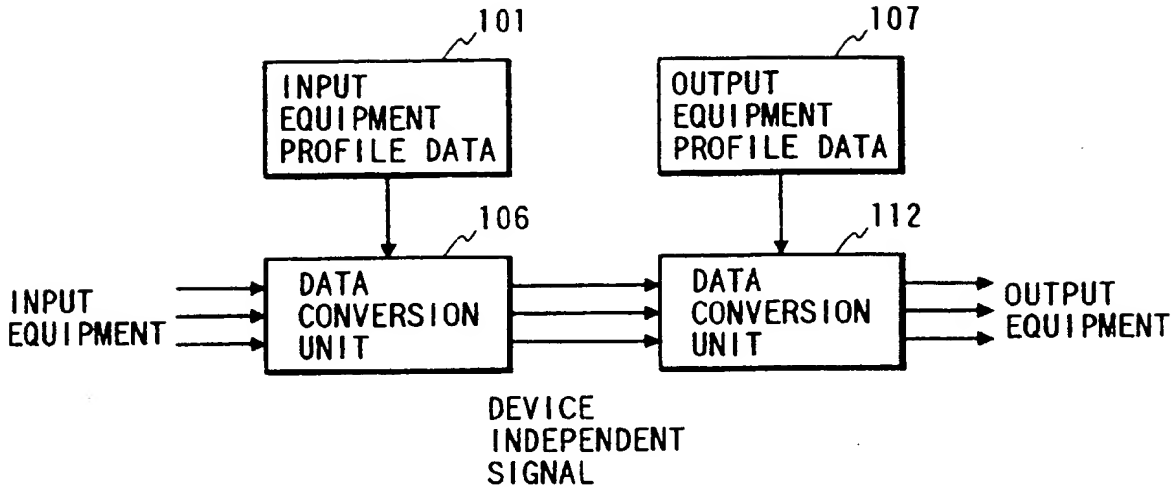

101
INPUT EQUIPMENT PROFILE DATA
107
OUTPUT EQUIPMENT PROFILE DATA
106
112
INPUT EQUIPMENT
DATA CONVERSION UNIT
DATA CONVERSION UNIT
OUTPUT EQUIPMENT
DEVICE INDEPENDENT SIGNAL

FIG. 15

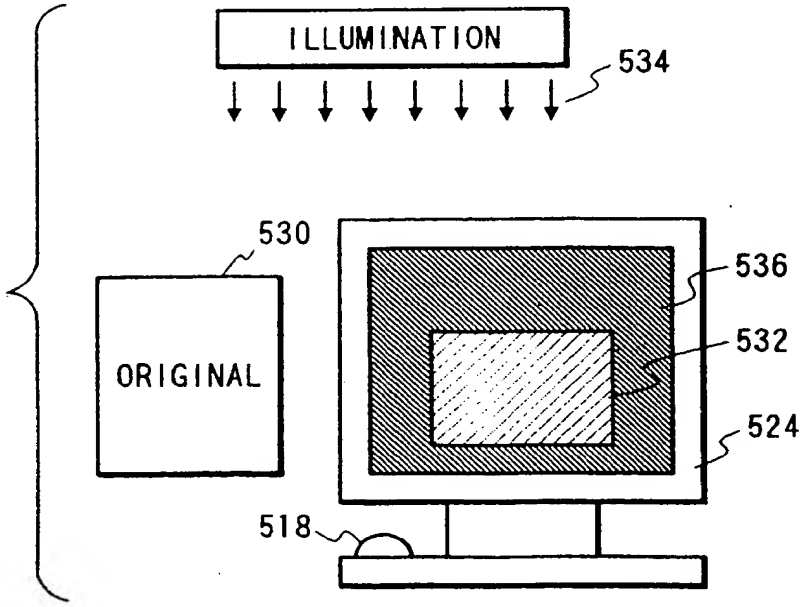
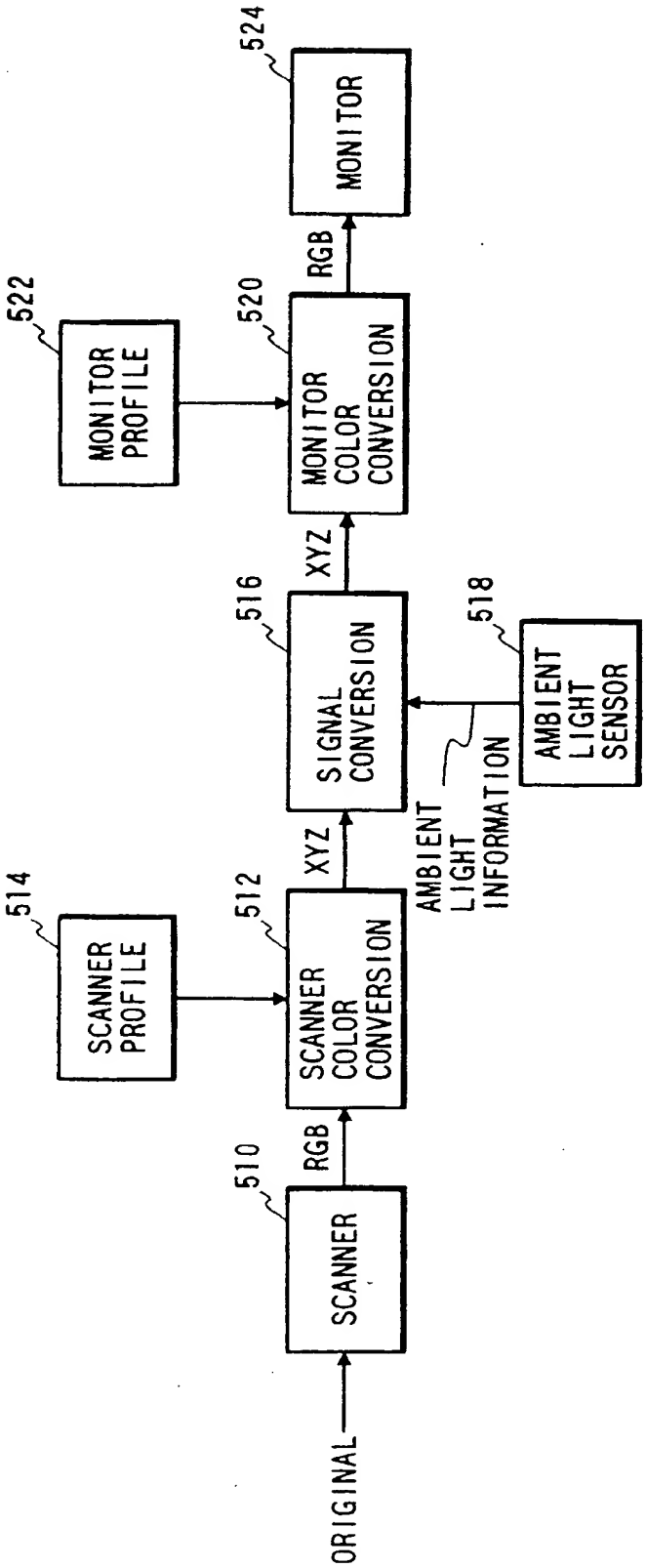

ILLUMINATION
534
530
ORIGINAL
536
532
524
518

FIG. 14


ORIGINAL
SCANNER
510
RGB
SCANNER COLOR CONVERSION
512
SCANNER PROFILE
514
XYZ
SIGNAL CONVERSION
516
AMBIENT LIGHT INFORMATION
AMBIENT LIGHT SENSOR
518
XYZ
MONITOR COLOR CONVERSION
520
MONITOR PROFILE
522
RGB
MONITOR
524

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 767 445 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
02.05.1997 Bulletin 1997/18

(43) Date of publication A2:
09.04.1997 Bulletin 1997/15

(51) Int Cl.[6]: **G06T 11/00**, G06T 7/40

(21) Application number: **96307166.7**

(22) Date of filing: **30.09.1996**

(84) Designated Contracting States:
DE ES FR GB IT NL

(30) Priority: **02.10.1995 JP 255140/95**
28.12.1995 JP 343849/95

(71) Applicant: **CANON KABUSHIKI KAISHA**
Tokyo (JP)

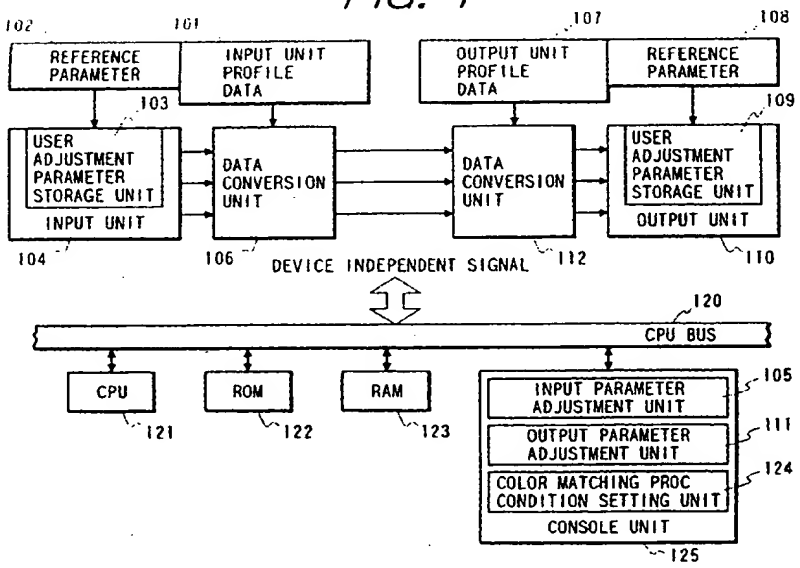
(72) Inventors:
- **Hidaka, Yumiko**
  Tokyo (JP)
- **Mizuno, Toshiyuki**
  Tokyo (JP)
- **Shiraiwa, Yoshinobu**
  Tokyo (JP)

(74) Representative:
Beresford, Keith Denis Lewis et al
BERESFORD & Co.
2-5 Warwick Court
High Holborn
London WC1R 5DJ (GB)

(54) Image processing apparatus and method

(57) An image processing apparatus is constructed by a setting circuit for manually setting a first color processing parameter, a first color processing circuit for performing a first color process by using the first color processing parameter, a storing circuit for storing a second color processing parameter set in correspondence to the first color processing parameter as a reference value, and a second color processing circuit for performing a second color process different from the first color process by using the second color processing parameter, wherein in case of making the second color processing circuit function, the first color processing parameter is set to the reference value.

FIG. 1



EP 0 767 445 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 7166

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	JOURNAL OF ELECTRONIC IMAGING, vol. 2, no. 3, July 1993, US, pages 213-224, XP000394880 KANAMORI E.A.: "FAST COLOR PROCESSOR WITH PROGRAMMABLE INTERPOLATION BY SMALL MEMORY (PRISM)" * page 216, left-hand column, line 3 - line 31; figures 1,2 * * page 223, left-hand column, line 18 - line 42 *	1-11	G06T11/00 G06T7/40
X	EP 0 565 283 A (SCITEX CORP LTD) 13 October 1993 * column 2, line 42 - column 3, line 24 * * column 11, line 52 - column 12, line 7 * * column 13, line 8 - column 14, line 12 *	1,2,4, 8-11	
X	WO 94 30003 A (TALIGENT INC) 22 December 1994 * page 5, line 4 - line 13 * * page 35, line 1 - line 20; figure 9 *	1-4,8-11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X	WO 91 10316 A (EASTMAN KODAK CO) 11 July 1991 * page 6, line 12 - page 7, line 27 * * page 10, line 20 - page 11, line 19 *	1,2,4, 8-11	H04N
X	US 5 349 452 A (MAEDA MASAHIRO ET AL) 20 September 1994 * page 4, line 23 - page 5, line 21; figure 1 *	1,2,4, 8-11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	18 February 1997	Burgaud, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☑ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)